WHAT IS CLAIMED AS NEW AND DESIRED TO BE SECURED BY LETTERS PATENT OF THE UNITED STATES IS:

1. A pressure swing adsorption process comprising the step of:

separating a gas mixture by absorbing at least one gas component in adsorbent beds provided within a plurality of vessels,

wherein the separating step has at least a two-stage pressure equalization and is performed with no more than five valves per vessel of the plurality of vessels.

2. The process according to Claim 1, wherein the separating step is performed with no more than four valves per vessel of the plurality of vessels.

3. The process according to Claim 2, wherein the process is performed using at least five vessels.

4. The process according to Claim 3, wherein the separating step is performed with no more than four valves per vessel of the plurality of vessels.

5. The process according to Claim 1, wherein the separating step has at least a three-stage pressure equalization.

6. The process according to Claim 1, wherein the process is performed using six vessels, and wherein the separating step has a three-stage pressure equalization.

7. The process according to Claim 5, wherein the separating step is performed with no more than four valves per vessel of the plurality of vessels.

8. The process according to Claim 1, wherein the process is performed using seven vessels, and wherein the separating step has a three-stage pressure equalization.

9. The process according to Claim 1, further comprising the step of providing a first equalization conduit that connects each vessel of the plurality of vessels.

10. The process according to Claim 9, wherein the two-stage pressure equalization

occurs via the first equalization conduit.

11. The process according to Claim 10, further comprising the step of providing a first valve that fluidly connects the first equalization conduit to a first vessel of the plurality of vessels and does not prevent flow along the first equalization conduit to any remaining vessels of the plurality of vessels.

12. The process according to Claim 9, further comprising the step of providing a second equalization conduit that connects each vessel of the plurality of vessels, wherein the two-stage pressure equalization occurs via the first equalization conduit and the second equalization conduit.

13. The process according to Claim 12, further comprising the step of providing a second valve that fluidly connects the second equalization conduit to the first vessel of the plurality of vessels and does not prevent flow along the second equalization conduit to any remaining vessels of the plurality of vessels.

14. The process according to Claim 13, wherein the first valve provides a first predetermined flow rate when in an open state, and wherein the second valve provides a second predetermined flow rate when in an open state.

15. The process according to Claim 14, wherein the first predetermined flow rate is different from the second predetermined flow rate, and wherein the first valve is in the open state during a first stage of the two-stage pressure equalization and the second valve is in the open state during a second stage of the two-stage pressure equalization.

16. The process according to Claim 1, wherein the plurality of vessels each have:

a first opening connected to a source inlet manifold via a first valve and connected to a waste outlet manifold via a second valve; and

a second opening connected to a product outlet manifold via a third valve and

connected to an equalization conduit via a fourth valve and a fifth valve, the equalization conduit connecting each vessel of the plurality of vessels.

17. The process according to Claim 16, wherein the fourth valve and the fifth valve do not prevent flow along the equalization conduit to any other vessel of the plurality of vessels.

18. The process according to Claim 16, wherein the fourth valve provides a first predetermined flow rate when in an open state, and wherein the fifth valve provides a second predetermined flow rate when in an open state.

19. The process according to Claim 18, wherein the first predetermined flow rate is different from the second predetermined flow rate, and wherein the fourth valve is in the open state during a first stage of the two-stage pressure equalization and the fifth valve is in the open state during a second stage of the two-stage pressure equalization.

20. A pressure swing adsorption process for separating a gas mixture by absorbing at least one gas component in adsorbent beds provided within a plurality of vessels, wherein the plurality of vessels are cyclically operated, the process comprising:

an adsorption step;

a first pressure equalization step having at least two stages, the first pressure equalization step decreasing pressure;

a purge step; and

a second pressure equalization step having at least two stages, the second pressure equalization step increasing pressure,

wherein said process is performed with no more than five valves per vessel of the plurality of vessels.

21. The process according to Claim 20, wherein said process is performed with no

more than four valves per vessel of the plurality of vessels.

22. The process according to Claim 21, wherein the process is performed using at least five vessels.

23. The process according to Claim 20, wherein the first pressure equalization step has at least three stages, and wherein the second pressure equalization step has at least three stages.

24. The process according to Claim 20, wherein the process is performed using six vessels, wherein the first pressure equalization step has three stages, and wherein the second pressure equalization step has three stages.

25. The process according to Claim 24, wherein the separating step is performed with no more than four valves per vessel of the plurality of vessels.

26. The process according to Claim 20, wherein the process is performed using seven vessels, wherein the first pressure equalization step has three stages, and wherein the second pressure equalization step has three stages.

27. The process according to Claim 20, wherein

the first pressure equalization step comprises at least two pressure equalization/depressurization stages, and a cocurrent depressurization providing purge gas step; and

the second pressure equalization step comprises at least two pressure equalization/repressurization stages, and a final repressurization step.

28. The process according to Claim 27, wherein all pressure equalization/depressurization stages of the first pressure equalization step occur prior to the cocurrent depressurization providing purge gas step.

29. The process according to Claim 20, wherein said process further comprises a

countercurrent blowdown step prior to the purge step.

30. The process according to Claim 20, further comprising the step of providing a first equalization conduit that connects each vessel of the plurality of vessels.

31. The process according to Claim 30, wherein the first pressure equalization step and the second pressure equalization step occur via the first equalization conduit.

32. The process according to Claim 31, further comprising the step of providing a valve that fluidly connects the first equalization conduit to a first vessel of the plurality of vessels and does not prevent flow along the first equalization conduit to any remaining vessels of the plurality of vessels.

33. The process according to Claim 30, further comprising the step of providing a second equalization conduit that connects each vessel of the plurality of vessels, wherein the first pressure equalization step and the second pressure equalization step occur via the first equalization conduit and the second equalization conduit.

34. The process according to Claim 33, further comprising the step of providing a second valve that fluidly connects the second equalization conduit to the first vessel of the plurality of vessels and does not prevent flow along the second equalization conduit to any remaining vessels of the plurality of vessels.

35. The process according to Claim 34, wherein the first valve provides a first predetermined flow rate when in an open state, wherein the second valve provides a second predetermined flow rate when in an open state, and wherein the first predetermined flow rate is different from the second predetermined flow rate.

36. The process according to Claim 30, further comprising the step of providing a second equalization conduit that connects each vessel of the plurality of vessels, wherein the first pressure equalization step and the second pressure equalization step occur via the first

equalization conduit and the third equalization step and the cocurrent depressurization step occur via the second equalization conduit.

37. The process according to Claim 20, wherein the plurality of vessels each have:

a first opening connected to a source inlet manifold via a first valve and connected to a waste outlet manifold via a second valve; and

a second opening connected to a product outlet manifold via a third valve and connected to an equalization conduit via a fourth valve and a fifth valve, the equalization conduit connecting each vessel of the plurality of vessels.

38. The process according to Claim 37, wherein the fourth valve and the fifth valve do not prevent flow along the equalization conduit to any other vessel of the plurality of vessels.

39. The process according to Claim 37, wherein the fourth valve provides a first predetermined flow rate when in an open state, wherein the fifth valve provides a second predetermined flow rate when in an open state, and wherein the first predetermined flow rate is different from the second predetermined flow rate.

40. A pressure swing adsorption system, comprising:

a plurality of vessels each having:

a first opening connected to a source inlet manifold via a first valve and connected to a waste outlet manifold via a second valve; and

a second opening connected to a product outlet manifold via a third valve and connected to an equalization conduit via a fourth valve and a fifth valve, said equalization conduit connecting each vessel of said plurality of vessels,

wherein said pressure swing adsorption system includes no more than five valves per vessel of said plurality of vessels.

41. The pressure swing adsorption system according to Claim 40, wherein said fourth valve and said fifth valve do not prevent flow along said equalization conduit to any other vessel of said plurality of vessels.

42. The pressure swing adsorption system according to Claim 40, wherein said fourth valve provides a first predetermined flow rate when in an open state, and wherein said fifth valve provides a second predetermined flow rate when in an open state.

43. The pressure swing adsorption system according to Claim 42, wherein said first predetermined flow rate is different from said second predetermined flow rate.

44. A pressure swing adsorption system, comprising:

a plurality of vessels each having:

a first opening connected to a source inlet manifold via a first valve and connected to a waste outlet manifold via a second valve; and

a second opening connected to a product outlet manifold via a third valve and connected to an equalization conduit via a fourth valve and a fifth valve, said equalization conduit connecting each vessel of said plurality of vessels,

wherein said fourth valve provides a first predetermined flow rate when in an open state, and

wherein said fifth valve provides a second predetermined flow rate when in an open state.

45. The pressure swing adsorption system according to Claim 44, wherein said fourth valve and said fifth valve do not prevent flow along said equalization conduit to any other vessel of said plurality of vessels.

46. The pressure swing adsorption system according to Claim 44, wherein said first predetermined flow rate is different from said second predetermined flow rate.

47. The pressure swing adsorption system according to Claim 44, wherein said pressure swing adsorption system includes no more than five valves per vessel of said plurality of vessels.

48. A pressure swing adsorption system, comprising:

at least five vessels each having:

a first opening connected to a source inlet manifold via a first valve and connected to a waste outlet manifold via a second valve; and

a second opening connected to a product outlet manifold via a third valve and connected to an equalization conduit via a fourth valve, said equalization conduit connecting each vessel,

wherein said pressure swing adsorption system includes no more than four valves per vessel.

49. The pressure swing adsorption system according to Claim 48, wherein said pressure swing adsorption system includes six vessels.

50. The pressure swing adsorption system according to Claim 48, wherein said fourth valve does not prevent flow along said equalization conduit to any other vessel.

51. A pressure swing adsorption process comprising the steps of:

separating a gas mixture by absorbing at least one gas component in adsorbent beds provided within a plurality of vessels,

wherein the separating step is initially performed using a pressure swing adsorption cycle for n vessels, where n is equal to a number of vessels initially operating to perform the separating step, and

wherein, upon failure of at least one of a specific vessel and a valve directly associated with the specific vessel, the separating step is performed using a pressure swing

adsorption cycle for n-1 vessels by bypassing the specific vessel.

52. The pressure swing adsorption process according to Claim 51, wherein the separating step has at least a two-stage pressure equalization and is performed with no more than five valves per vessel.

53. A pressure swing adsorption process for separating a gas mixture by absorbing at least one gas component in adsorbent beds provided within a plurality of vessels, wherein the plurality of vessels are cyclically operated, the process comprising:

an adsorption step;

a first pressure equalization step having at least two stages, the first pressure equalization step decreasing pressure;

a purge step; and

a second pressure equalization step having at least two stages, the second pressure equalization step increasing pressure,

wherein the process is initially performed using a pressure swing adsorption cycle for n vessels, where n is equal to a number of vessels initially operating to perform the process, and

wherein, upon failure of at least one of a specific vessel and a valve directly associated with the specific vessel, the process is performed using a pressure swing adsorption cycle for n-1 vessels by bypassing the specific vessel.

54. The pressure swing adsorption process according to Claim 53, wherein said process is performed with no more than five valves per vessel.